CAPT Science Performance Task

Keep It Hot

Have you ever bought a hot drink in a paper cup and found that it was cold before you finished drinking it? Is there anything that can be done to a paper cup to help keep a hot drink warm? Wrapping the cup to insulate it might help, but what should you use to wrap the cup?

Your Task

You will design and conduct an experiment to explore the insulating abilities of different materials for keeping a liquid in a paper cup warm. During this activity you will work with a lab partner (or possibly two partners). You must keep your own individual lab notes because after you finish, you will work independently to write a lab report about your experiment.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided. You may use additional materials or equipment if they are available.

---

6 paper cups with lids
1 sheet of cloth
2 sheets of black construction paper
2 sheets of white construction paper
1 large sheet of aluminum foil
1 liter of hot water
Access to a clock or watch with a second hand
2 large styrofoam cups with lids to carry hot water
Splash-proof goggles and aprons
2 thermometers
Graduated cylinder
Scissors
Ruler
Tape
Paper towels for cleanup

Steps to Follow

1. **In your own words, clearly state the problem you are going to investigate.** Include a clear identification of the independent and dependent variables that will be studied.

2. **Design an experiment to solve the problem.** Your experimental design should match your statement of the problem, should control variables, and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate.

   Write your experimental design on the page provided. Show your design to your teacher before you begin your experiment.

   Note: The hot water used in your experiment should be in the range of 60° to 70° Celsius. The water should not be heated above 70°C for safety reasons.

3. **After receiving approval from your teacher, work with your partner to carry out your experiment.** Your teacher's approval does not necessarily mean that your teacher thinks your experiment is well designed. It simply means that in your teacher' s judgment your experiment is not dangerous or likely to cause an unnecessary mess.

4. **While conducting your experiment, take notes on the attached pages.** Include the results of your experiment. All data should be organized in tables, charts or graphs, which should be properly labeled.

   Your notes will **not** be scored, but they will be helpful to you later as you work independently to write about your experiment and results. You **must** keep your own notes because you will not work with your partner when you write your lab report.

   When you have finished your experiment, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.

(Students are provided with four blank pages for their notes, as well as a grid for tables, charts or graphs.)

Directions for Writing Your Laboratory Report

Working on your own, summarize your experiment and results. Use your own notes that you took previously while working with your partner. You may wish to write a first draft of your report on scratch paper. Space for your final report is provided on the following pages in this booklet. You will have approximately 30 minutes to complete your report.

Your report should include the following:

- **A clear statement of the problem you investigated.** Include a clear identification of the independent and dependent variables that were studied.

- **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone else could easily replicate your experiment.

- **The results of your experiment.** All of your data should be organized in tables, charts or graphs, which should be properly labeled.

- **Your conclusions from the experiment.** Your conclusions should be fully supported by data.

- **Comments about how valid you think your conclusions are.** In other words, how much confidence do you have in your results and conclusions? Any factors that contribute to a lack of confidence in the results or conclusions should be discussed. Also, include ways that your experiment could be improved if you were to do it again.

(Students are provided with four lined pages for their reports, as well as a grid for tables, charts or graphs.)

CAPT Experimentation Questions

Keep it Hot

A class of students performed a series of experiments to determine which of several materials would be most effective for insulating a paper cup.

One group of lab partners tested four different materials: black paper, white paper, aluminum foil and cloth. The following table shows their results.

Insulating Material	Temperature of Water in Cups at Start of Experiment	Temperature After 5 Minutes	Temperature After 10 Minutes
Black Paper	70°C	60°C	52°C
White Paper	50°C	45°C	40°C
Aluminum foil	85°C	70°C	60°C
Cloth	60°C	54°C	48°C

1. This is the group's statement of the problem: "We wanted to see which of four materials would be good for wrapping around a cup." Is this a clear statement of the problem? Explain why or why not.

2. The students concluded that the white paper was the most effective insulator because the cup wrapped in white paper showed the smallest drop in temperature. Is this group's conclusion valid? Explain why or why not.

Another group in the class tried to use various materials and combinations of materials. The following table shows their results.

Insulating Material	Temperature of Water in Cups at Start of Experiment	Temperature After 5 Minutes	Temperature After 10 Minutes
4 thicknesses of black paper	80°C	74°C	70°C
4 thicknesses of white paper	80°C	75°C	71°C
4 thicknesses of aluminum foil	80°C	72°C	66°C
4 thicknesses of cloth	80°C	73°C	67°C
1 thickness each of black paper, white paper, aluminum foil and cloth	80°C	78°C	76°C

3. What valid conclusions can you draw from these results? Explain your answer.

4. Do you have enough information to replicate this group's experiment? If you think you do, tell what information you have. If you think you do not, tell what other information you would need.